

CLAIMS

1. A conduit having its surface or a portion of its surface coated with a fluid-repellent layer wherein said layer comprises, or is produced from, a fluorocarbon silane or a substantially aqueous emulsion; said emulsion comprises
 5 or is produced from (1) a fluorocarbon silane or its hydrolyzate, (2) water, and (3) optionally a surfactant, a silicon compound, a catalyst which is an acid or base, or combinations of two or more thereof; said fluorocarbon silane has the formula $R_f-(CH_2)_p-Si\{-(O-CH_2CH_2)_n-OR^1\}_3$; said silicon compound is a silicate or an organoalkoxysilane; R_f is a C_{3-18} perfluoroalkyl group or combinations of two or
 10 more thereof; each R^1 is independently one or more C_{1-3} alkyl groups; p is 2 to 4; and n is 2 to 10.
2. A conduit according to claim 1 wherein said conduit is a nozzle.
3. A conduit according to claim 1 wherein said layer has a thickness of from about 0.1 nm to about 10,000 nm.
- 15 4. A conduit according to claim 2 wherein said layer has a thickness of from about 1 nm to about 1000 nm.
5. A conduit according to claim 3 wherein said emulsion comprises or is produced from said hydrolyzed fluorocarbon silane, said surfactant, said silicon compound, and said catalyst.
- 20 6. A conduit according to claim 4 wherein said emulsion comprises or is produced from said hydrolyzed fluorocarbon silane, said surfactant, said silicon compound, and said catalyst.
7. A conduit according to claim 5 wherein said fluorocarbon silane is perfluoro alkyl ethyl tris(2-(2-methoxyethoxy)ethoxy)silane, perfluoro alkyl ethyl
 25 tris(2-(2-(2-methoxyethoxy)ethoxy)ethoxy) silane, or combinations thereof.
8. A conduit according to claim 5 wherein said silicon compound is a silicate or organoalkoxysilane, said silicate has the formula of $Si-(R)_4$, each R is independently OCH_3 , OCH_2CH_3 , $(OCH_2CH_2)_mOCH_3$, $m=1-10$, or combinations of two or more thereof; said organoalkoxysilane has the formula of $R^2_qSi(OR^3)_{4-q}$,
 30 each R^2 is independently an alkyl group containing about 1 to about 10 carbon

atoms; each R^3 is independently an alkyl group containing 1 to about 3 carbon atoms; and $q=1-3$.

9. A conduit according to claim 8 wherein said fluorocarbon silane is perfluoro alkyl ethyl tris(2-(2-methoxyethoxy)ethoxy)silane, perfluoro alkyl ethyl tris(2-(2-(2-methoxyethoxy)ethoxy)ethoxy) silane, or combinations thereof.

10. A conduit according to claim 9 wherein said silicon compound is tetrakis(2-(2-methoxyethoxy)ethoxy)silicate, dimethyldimethoxysilane, methyltrimethoxy silane, methyltriethoxysilane, 3-aminopropyltriethoxy silane, N-(2-aminoethyl)3-aminopropyldiethoxy silane, 3-glycidoxypropyltrimethoxy silane, one or more partial condensation products thereof, or combinations of two or more thereof.

11. A conduit according to claim 10 wherein said surfactant is R_f^1 - CH_2CH_2 -O-(CH_2CH_2 O)₁₁-H, C_9H_{19} - C_6H_4 -O-(CH_2CH_2 O)₅₀-H, R_f^1 - $CH_2CH_2SCH_2CH(OH)CH_2N(CH_3)_3^+Cl^-$, $C_{12}H_{25}(OCH_2CH_2)_4OSO_3NH_4^+$, $C_{12}H_{27}$ - C_6H_4 - SO_3Na^+ , or combinations or two or more thereof wherein R_f^1 is a C_{3-18} perfluoroalkyl group.

12. A conduit according to claim 6 wherein said fluorocarbon silane is perfluoro alkyl ethyl tris(2-(2-methoxyethoxy)ethoxy)silane, perfluoro alkyl ethyl tris(2-(2-(2-methoxyethoxy)ethoxy)ethoxy) silane, or combinations thereof.

13. A conduit according to claim 6 wherein said silicon compound is a silicate or organoalkoxysilane, said silicate has the formula of $Si(R)_4$, each R is independently OCH_3 , OCH_2CH_3 , $(OCH_2CH_2)_mOCH_3$, $m=1-10$, or combinations of two or more thereof; said organoalkoxysilane has the formula of $R^2_qSi(OR^3)_{4-q}$, each R^2 is independently an alkyl group containing about 1 to about 10 carbon atoms; each R^3 is independently an alkyl group containing 1 to about 3 carbon atoms; and $q=1-3$.

14. A conduit according to claim 13 wherein said fluorocarbon silane is perfluoro alkyl ethyl tris(2-(2-methoxyethoxy)ethoxy)silane, perfluoro alkyl ethyl tris(2-(2-(2-methoxyethoxy)ethoxy)ethoxy) silane, or combinations thereof.

15. A conduit according to claim 14 wherein said silicon compound is tetrakis(2-(2-methoxyethoxy)ethoxy)silicate, dimethyldimethoxysilane,

methyltrimethoxy silane, methyltriethoxysilane, 3-aminopropyltriethoxy silane, N-(2-aminoethyl)3-aminopropyldiethoxy silane, 3-glycidoxypopyltrimethoxy silane, one or more partial condensation products thereof, or combinations of two or more thereof.

5 16. A conduit according to claim 15 wherein said surfactant is R_f^1 - $CH_2CH_2-O-(CH_2CH_2O)_{11}-H$, $C_9H_{19}-C_6H_4-O-(CH_2CH_2O)_{50}-H$, R_f^1 - $CH_2CH_2SCH_2CH(OH)CH_2N(CH_3)_3^+Cl^-$, $C_{12}H_{25}(OCH_2CH_2)_4OSO_3^-NH_4^+$, $C_{12}H_{27}-C_6H_4-SO_3^-Na^+$, or combinations of two or more thereof wherein R_f^1 is a C_{3-18} perfluoroalkyl group.

10 17. A conduit according to claim 16 wherein said conduit is a ceramic, polyimide, or metal, or is produced from a ceramic, polyimide, or metal.

 18. A conduit according to claim 17 wherein said conduit is an ink jet printer nozzle or a nozzle for a machine.

 19. A process comprising (1) contacting on the surface of a conduit
15 with a substantially aqueous emulsion comprising, or produced from, a hydrolyzed fluorocarbon silane product, a surfactant, a silicon compound, an acid or base, and water; and (2) drying said emulsion to produce a thin-film having a thickness of from about 0.1 nm to about 10,000 nm on the surface of said conduit wherein said fluorocarbon silane has the formula $R_f-(CH_2)_p-Si\{(O-CH_2CH_2)_n-$
20 $OR^1\}_3$; said silicon compound is a silicate or an organoalkoxysilane; R_f is a C_{3-18} perfluoroalkyl group or combinations of two or more thereof; each R^1 is independently one or more C_{1-3} alkyl groups; p is 2 to 4; and n is 2 to 10.

 20. A process according to claim 19 wherein said conduit is a nozzle.

 21. A process according to claim 20 wherein said emulsion comprises
25 or is produced from said hydrolyzed fluorocarbon silane, said surfactant, said silicon compound, and said catalyst.

 22. A process according to claim 21 wherein said fluorocarbon silane is perfluoro alkyl ethyl tris(2-(2-methoxyethoxy)ethoxy)silane, perfluoro alkyl ethyl tris(2-(2-(2-methoxyethoxy)ethoxy)ethoxy) silane, or combinations thereof.

23. A process according to claim 20 wherein said silicon compound is a silicate or organoalkoxysilane, said silicate has the formula of $\text{Si}(\text{R})_4$, each R is independently OCH_3 , OCH_2CH_3 , $(\text{OCH}_2\text{CH}_2)_m\text{OCH}_3$, $m=1-10$, or combinations of two or more thereof; said organoalkoxysilane has the formula of $\text{R}^2_q\text{Si}(\text{OR}^3)_{4-q}$,
 5 each R^2 is independently an alkyl group containing about 1 to about 10 carbon atoms; each R^3 is independently an alkyl group containing 1 to about 3 carbon atoms; and $q=1-3$.

24. A process according to claim 23 wherein said fluorocarbon silane is perfluoro alkyl ethyl tris(2-(2-methoxyethoxy)ethoxy)silane, perfluoro alkyl
 10 ethyl tris(2-(2-(2-methoxyethoxy)ethoxy)ethoxy) silane, or combinations thereof.

25. A process according to claim 24 wherein said silicon compound is tetrakis(2-(2-methoxyethoxy)ethoxy)silicate, dimethyldimethoxysilane, methyltrimethoxy silane, methyltriethoxysilane, 3-aminopropyltriethoxy silane, N-(2-aminoethyl)3-aminopropyldiethoxy silane, 3-glycidoxypropyltrimethoxy
 15 silane, one or more partial condensation products thereof, or combinations of two or more thereof.

26. A process according to claim 25 wherein said surfactant is R_f^1 - CH_2CH_2 -O-($\text{CH}_2\text{CH}_2\text{O}$)₁₁-H, C_9H_{19} - C_6H_4 -O-($\text{CH}_2\text{CH}_2\text{O}$)₅₀-H, R_f^1 - $\text{CH}_2\text{CH}_2\text{SCH}_2\text{CH}(\text{OH})\text{CH}_2\text{N}(\text{CH}_3)_3^+\text{Cl}^-$, $\text{C}_{12}\text{H}_{25}(\text{OCH}_2\text{CH}_2)_4\text{OSO}_3^-\text{NH}_4^+$, $\text{C}_{12}\text{H}_{27}$ -
 20 C_6H_4 - SO_3^-Na^+ , or combinations or two or more thereof wherein R_f^1 is a C_{3-18} perfluoroalkyl group.

27. A process according to claim 26 wherein said conduit is a ceramic, polyimide, or metal, or is produced from a ceramic, polyimide, or metal.

28. A process according to claim 27 wherein said conduit is an ink jet
 25 printer nozzle or a nozzle for a machine.

29. A process according to claim 13 wherein said drying is carried out in a range from 150°C-500°C.